Calculation By: M. Adamowski
Checked By:
Project No.: LAPD
Date: 10/28/09
Revision: A

Calc of LAPD tank heat input from surroundings:

Tank Data

ref: Tank drawing Y08-125-1, rev 2 by Midwest Imperial Steel Fabricators.

Tank Diameter

$Tank_D := 10 \cdot ft + 0 \cdot in$

Tank Height (straight side)

$Tank_H := 10 \cdot ft + 0 \cdot in$

Tank Temperature (liquid Argon)

$T_{Tank} := 87 \cdot K$

Environment Data

Temperature outside tank

$T_{out} := 300 \cdot K$

300 K is 80.3 F

Insulation Data

ref: Insulation types, thickness and number of layers from the tank insulation drawing 3942.000-ME-466366, rev A, by Fermi. Thermal conductivity k-factors from insulation vendors, ITW and Owens Corning.

Trymer section thickness

$W_{trymer} := 2 \cdot in$

Fiberglass 701 section thickness

$W_{FG701} := 2 \cdot in$

Fiberglass 702 thickness

$W_{FG702} := 2 \cdot in$

Trymer k-factor

$k_{trymer} := 0.027 \cdot \frac{W}{m \cdot K}$

Fiberglass 701 k-factor

$k_{FG701} := 0.067 \cdot \frac{W}{m \cdot K}$

Fiberglass 702 k-factor

$k_{FG702} := 0.060 \cdot \frac{W}{m \cdot K}$

Heat absorbed through tank floor

The basic heat transfer formula is used to calculate the heat absorbed for a given AREA covered by a given THICKNESS of insulation exposed to a given temperature difference, (Tout-Tin) with a thermal conductivity of k_factor.

$$q := \frac{(k\_factor \cdot AREA)}{THICKNESS} \cdot (T_{out} - T_{in})$$

Number of trymer layers covering the bottom of the tank

$N_{trymer} := 3$

$$Area_{floor} := \pi \cdot \left(\frac{Tank_D}{2}\right)^2 \qquad Area_{floor} = 78.54 \cdot ft^2$$

$$Floor_Q := \frac{k_{trymer} \cdot Area_{floor}}{N_{trymer} \cdot W_{trymer}} \cdot (T_{out} - T_{Tank}) \qquad Floor_Q = 275.346 \cdot W$$

Heat absorbed through tank side

Number of Fiberglass 702 layers covering the side of the tank

$$N_{FG702} := 5$$

Thickness of Trymer skin on top of 702

$$Skin_{W\_trymer} := 0.75 \cdot in$$

Equivalent thickness of 702 for the Trymer skin (this keeps the wall heat input calc simple)

$$Skin_{W\_702} := Skin_{W\_trymer} \cdot \frac{k_{FG702}}{k_{trymer}} \qquad Skin_{W\_702} = 1.667 \cdot in$$

$$Area_{side} := 2\pi \cdot \left(\frac{Tank_D}{2} \right) \cdot Tank_H \qquad Area_{side} = 314.159 \cdot ft^2$$

$$Side_Q := \frac{k_{FG702} \cdot Area_{side}}{N_{FG702} \cdot \left(W_{FG702} + Skin_{W\_702} \right)} \cdot \left(T_{out} - T_{Tank} \right)$$

$$Side_Q = 801 \cdot W$$

Heat absorbed through tank top

The tank top head is assumed to be an 2:1 ellipsoidal head.
The area of a 2:1 ellipsoidal head can estimated to within about 2% using a formula adapted from Chemical & Process Technology.

ref: http://webwormcpt.blogspot.com/2009/04/calculate-wetted-surface-area-for_11.html.

Number of Fiberglass 701 layers covering the side of the tank

$$N_{FG701} := 5$$

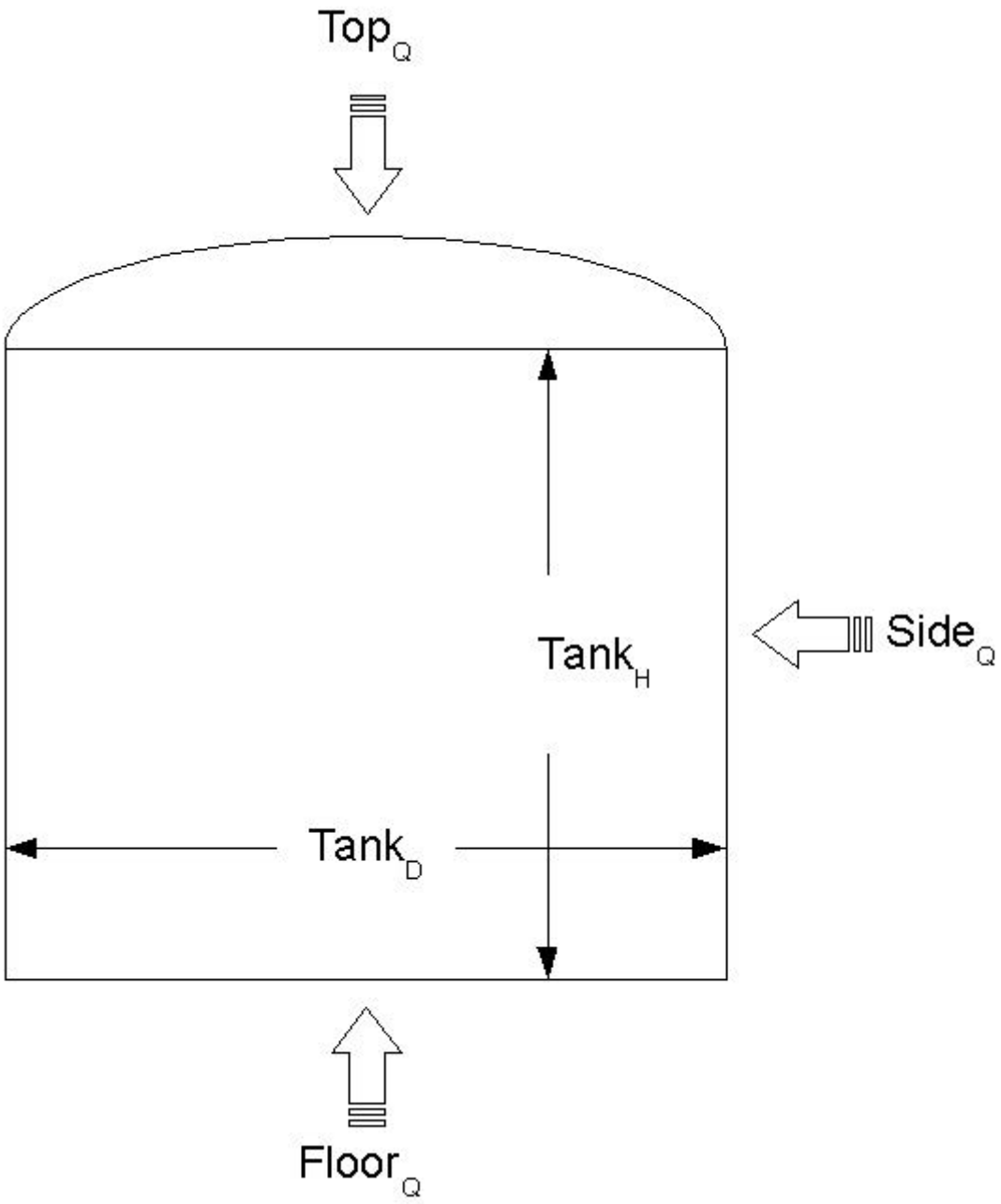
$$Area_{top} := \frac{2.178}{2 \cdot \pi} \left(Tank_D\right)^2 \cdot \pi$$

$$Area_{top} = 108.9 \cdot ft^2$$

$$Top_Q := \frac{k_{FG701} \cdot Area_{top}}{N_{FG701} \cdot W_{FG701}} \cdot \left(T_{out} - T_{Tank}\right)$$

$$Top_Q = 568.432 \cdot W$$

Summary of Heat absorbed by tank



$Top_Q = 568.4 \cdot W$ $Side_Q = 801 \cdot W$ $Floor_Q = 275.3 \cdot W$

$Total_Q := Top_Q + Side_Q + Floor_Q$ $Total_Q = 1645 \cdot W$